SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1911.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

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GENERAL PHYSICS.

1642. *A Balance for a Ten-kilogramme Load.* **K. Scheel.** (Zeitschr. Instrumentenk. 31. pp. 237–245, Aug., 1911. Communication from the Physikal.-Techn. Reichsanstalt.)—If we require the weight of the above load accurate to ± 0·1 mgm. the balance-arms must not change during the weighing by more than ± 0·002 μ. In like manner the suspended pans must not move laterally by more than this figure. In this balance the beam is supported by a cast-iron case, the pans being suspended inside the case. This arrangement gives greater stability to the beams and more freedom to the pans. The beam itself is covered by a copper cover in which is a window through which a mirror attached to the beam can be viewed by a telescope. The arrestment arrangements are within the case. Pans are arranged for weighing in air and in water. Examples are quoted to show the accuracy obtainable in the various conditions. P. E. S.

1643. *A Silica Standard of Length.* **G. W. C. Kaye.** (Roy. Soc., Proc. Ser. A. 85. pp. 430–447, Aug. 15, 1911.)—A criticism of materials used in making primary standards of length reveals objections to (1) copper alloys, (2) platinum, (3) iridio-platinum, (3) nickel, and (4) invar for various reasons. Fused silica, however, has a remarkable combination of good qualities: (*a*) very small thermal expansion, (*b*) very small thermal hysteresis, (*c*) cheapness, (*d*) small density; whereas the weak points in it, viz., (*a*) frangibility, (*b*) comparative low elasticity, and (*c*) slight solubility in water, can be treated as negligible, when, as in the case of a primary standard, only skilled operators handle it. The present metre standard, the first of its kind, consists of a tube of silica with horizontal slabs of the same material fused into its ends. These slabs are optically worked, plane and parallel. The undersides of the slabs are platinised and the excellent defining lines of the standard are made by ruling through the thin Pt-film with a diamond. The standard is supported at the Airy points. Care is taken to allow for viewing the defining lines through the slabs, also for viewing through water or other liquid. The standard after being made was annealed by slowly raising it to 450° C., maintaining it so for eight days, and subsequently cooling it, the latter process taking fourteen days. Annealing caused a shrinkage of about half a micron. P. E. S.

1644. *Change in Length of Hardened Steel.* **A. Leman** and **A. Werner.** (Zeitschr. Instrumentenk., Beib. 16. pp. 167–170, Aug. 15, 1911. Communication from the Physikal.-Techn. Reichsanstalt.)—Experiments made on end-standard of length show that changes occur after hardening if the standards are maintained at a temperature of 150° C. for several hours. After several hours (six in some cases) no further change takes place. The lengths are measured every hour during the process. P. E. S.

1645. *Pendulum Clocks and their Errors.* **H. R. A. Mallock.** (Roy. Soc., Proc. Ser. A. 85. pp. 505–526, Oct. 18, 1911.)—In this paper the author states the various causes which may bring about a change in the rate of a pendulum, and the permissible variation of the different arguments involved if the variation of rate due to each of them is not to exceed 1 part in 10^8. The causes of variation of rate may be grouped under three heads: (i) Such as would affect a pendulum swinging freely *in vacuo*; (ii) variations due to the action of the atmosphere on a free pendulum; (iii) variations due to the action of the mechanism which maintains the vibration. Of these the last is the most important, and the most difficult to deal with. The errors are discussed at length, and an escapement is described which appears to be an improvement on the dead-beat and gravity escapements, but which has had no extended trial as yet. A. W.

1646. *Investigation of Helical Springs of Circular Cross-section.* **L. Zacharias.** (Zeitschr. Vereines Deutsch. Ing. 55. pp. 1801–1807, Oct. 28, 1911.)—Neglecting the bending effect of a load P applied to a helical spring of mean radius r, length l and cross-section whose polar moment of inertia is θ_P, the relative axial movement of the ends $\Delta f = Pr^2l/G\theta_P$, G being the modulus of rigidity of material. The consideration of both bending and twisting leads to the equation $\Delta f = P\,r^2l\,(\sin^2\alpha/E\theta + \cos^2\alpha/G\theta_P)$, where E = modulus of elasticity, α = angle of the helix, θ = moment of inertia of cross-section of wire about a diam. The total relative motion at right angles to the plane of the axis (rotational) is $\Delta S = P\,r^2l \sin\alpha \cos\alpha\,(-1/E\theta + 1/G\theta_P)$. The tests were performed on springs of cold-drawn steel such as are found in practice, the ratio d/r of wire diam. to radius of helix being varied between 0·50 and 0·12 and the greatest angle of helix being 28°. Tests were carried out to determine the elongations under different loads. Torsional and tension tests were also made of straight test-pieces of the same batch of wires. Two sets of trials were run: one with constant ratio d/r and varying angles of helix, and the other with varying d/r and very small angle. By comparing the rigidity modulus as calculated from the elongations and as determined directly, a measure is obtained of the value of the theoretical formulæ. It is concluded that the modulus of rigidity found from a straight rod may be used without great error in spring calculations for cold-drawn steel if d/r lies between the limits mentioned. Further, the second expression for Δf is applicable when for G is substituted the value found for springs of small pitch (the first equation) and for E is substituted the value calculated from tests of straight rods of the same material. Finally, springs were tested to destruction, the stresses at break being calculated according to the formula

$\sigma_r = \frac{3}{8}\sigma + \frac{5}{8}\sqrt{(4\tau^2 + \sigma^2)}$, where $\sigma_r =$ resultant stress on material, $\sigma =$ bending stress, $\tau =$ torsion stress and Poisson's ratio is taken $= 4$. By substituting for τ and σ the expression becomes $\sigma_r = (20r/\pi d^3)(1 + \frac{3}{5}\sin \alpha)$ P; here $\alpha =$ angle of helix measured at fracture. C. A. M. S.

1647. *Compression Tests of Marble and Stone.* **T. v. Kármán.** (Zeitschr. Vereines Deutsch. Ing. 55. pp. 1749–1757, Oct. 21, 1911.)—This paper describes tests in compression of marble and sandstone. The specimens were subjected to an axial load in the testing machine simultaneously with a lateral pressure due to glycerine regulated by a pump. The author gives a synopsis of Mohr's theory of elastic failure, which assumes that induced shear on inclined planes is the determining factor. It is assumed that the middle principal stress plays no part, the difference between the greatest and least principal stresses having to be considered. The tests do not decide this point, since two principal stresses (the least) are always equal. If σ_1 and σ_3 are the greatest and least principal stresses, $\sigma =$ resultant normal stress and $\tau =$ resultant tangential stress on any plane inclined at angle θ to the direction of σ_3, then $\sigma = (\sigma_1 + \sigma_3)/2 + (\sigma_1 - \sigma_3)/2 . \cos 2\theta$ and $\tau = (\sigma_1 - \sigma_3)/2 . \sin 2\theta$, Mohr represented the relation between τ and σ by laying off $(\sigma_1 + \sigma_3)/2$ along the σ-axis and then drawing a circle from this point as centre and with radius $(\sigma_1 - \sigma_3)/2$. By varying σ_1 and σ_3 a series of circles so obtained which have an envelope called the "limiting curve," whose ordinate where it touches any circle $= (\sigma_1 - \sigma_3)/2 . \sin \phi = \tau$, where $\phi = 2\theta$ and $\theta =$ angle of the plane of failure in shear. The tests show that changes of shape due to the axial load are affected greatly by the lateral pressure. With little or no side pressure ($\sigma_3 = 0$) marble and sandstone give the ordinary curves of stress $(\sigma_1 - \sigma_3)$ to strain for brittle materials: as σ_3 increases to about 700–800 atmos. the material attains prefect plasticity, the elastic limit raising all the time; at higher values of σ_3, further deformation after elastic limit can only be induced by further loading axially, though the effect diminishes rapidly at high pressures. The results when plotted according to Mohr's method confirm his theory, the enveloping curve becoming horizontal for high values of σ_3, showing that the material flows by shear on planes at 45° to the axis. A table is given comparing values of ϕ (or 2θ) measured from the curves and calculated on Mohr's theory, and the agreement is remarkable. The materials were also tested micrographically. The microscope showed that permanent set may take place by relative shearing of the crystals at low values of σ_3, or by internal changes of the crystals, at high values of σ_3. The first form of failure occurs at a max. value of the shear stress which depends on the normal stress, and is accompanied by a weakening of the material on further loading, shear-markings appearing on the surface. The second form of failure occurs at a limiting constant shear value and the material hardens, no markings appearing. C. A. M. S.

1648. *Impact Tests at Various Temperatures.* **L. Guillet** and **L. Revillon.** (Rev. de Métallurgie, 7. pp. 837–844, 1910. Metallurgie, 8. pp. 588–590, Sept. 22, 1911.)—In order to complete their experiments [Abstract No. 1088 (1910)] the authors have carried out a series of impact tests on nickel steels of various compositions between 20° and 800° C. with the following results. Steel containing 0·125 per cent. carbon and 12·07 per cent. Ni is martensitic and very brittle at ordinary temperatures, but as soon as the comparatively low transition-point is passed (about 500° C.), the specimen bends without fracture. With 0·176 per cent. carbon and 20·40 per cent. Ni, steels are partly in the form of γ iron, and the results obtained depend not only on the temperature but also on the duration of heating. In steels containing 0·228 per cent. carbon and 12·27 per cent. Ni the impact strength increases steadily with the temperature. Steel containing 0·194 per cent. carbon and 27·87 per cent. Ni is wholly in the γ condition and gives a high impact strength which is more or less independent of temperature. With 0·776 per cent. carbon and 4·90 per cent. Ni, steels exist in the transition stage toward martensite and are very brittle below the transition temperature which is a little over 560° C. on heating and about 500° C. on cooling. In this temperature interval the steel completely loses its brittleness. Steel containing 1·05 per cent. carbon and 9·79 per cent. Ni is completely martensitic; its impact strength is very little affected up to the transition temperature (just above 500° C.), at which the shock strength suddenly increases. In a γ-iron steel containing 0·79 per cent. carbon and 25·06 per cent. Ni and a ferro-nickel containing 0·855 per cent. carbon and 82·80 per cent. Ni the impact strength passes through a minimum at about 228° C., rising to a maximum at about 480° C., after which it drops steadily. Ferro-nickel with 45 per cent. Ni falls to a minimum as regards impact strength at 450° C., while at 550° C. the specimens are devoid of brittleness. F. C. A. H. L.

1649. *Inclined Planes.* **A. G. Rossi.** (N. Cimento, 1. Ser. 6. pp. 835–847, May, 1911.)—Describes several new contrivances for studying the laws of falling bodies and of friction. One of them comprises a shaft rolling down an incline consisting of two metallic rails. Three rods, bearing heavy balls at their ends, are screwed into the centre of the shaft at right angles to its axis and at 120° to each other. The acceleration is very gradual. By varnishing the rails and making scratches in the varnish electric records of the passage of certain points may be obtained. The lubrication due to the melting of ice under pressure may be shown by another contrivance described. E. E. F.

1650. *Theory of Rotating Fluids.* **U. Crudeli.** (N. Cimento, 1. Ser. 6. pp. 487–442, June, 1911.)—An investigation of certain questions connected with the stability of rotating fluid masses. It appears that in the case of a cylinder of elliptical section and infinitely long axis, equilibrium is possible when it rotates about that axis with a velocity $= \sqrt{(\pi\kappa\sigma)}$, where κ is the constant of gravitation and σ is the density. The periodic time T of the earth, and its density σ are related to the original T_0 and σ_0 by the inequation $T > 0{\cdot}0678 T_0 \sqrt{(\sigma_0/\sigma)}$. E. E. F.

1651. *Dissipation of Energy.* **P. Barreca.** (N. Cimento, 2. Ser. 6. pp. 85–92, Aug., 1911.)—The author shows that there are certain weaknesses in the Kelvin-Helmholtz theorem of the dissipation of energy down to the final death of the molar world, one of them arising out of our ignorance as to whether the amount of matter and of entropy in the universe is limited or infinite. At the worst, the dissipation of energy can only be asymptotic, as the conditions attending its dissipation retard the rate of dissipation. E. E. F.

1652. *Brownian Movements.* **H. Fletcher.** (Phys. Rev. 88. pp. 81–110, Aug., 1911. Le Radium, 8. pp. 279–286, July, 1911.)—Gives a new deduction of the formulæ of Einstein and Langevin for the displacement of a Brownian particle, and fully discusses the effect of Brownian movements upon the apparent value of the electric charge carried by a particle suspended in a gas. It is shown that Brownian movements are fully explained, qualitatively and quantitatively, by the kinetic theory of gases. The displacements observed are used to calculate the value of Ne, and the mean value of 1785 values of Ne is found to be $2{\cdot}88 \times 10^{14}$, as compared with $2{\cdot}896 \times 10^{14}$ obtained by the electro-deposition of silver. Both N and Ne are determined from the same set of experiments, and not from different types of experiments as hitherto. The value for e (the electronic charge) is $5{\cdot}01 \times 10^{-10}$ e.s. unit, which is within 2 per cent. of the value obtained by Millikan. Finally, the irregular values of e obtained by Ehrenhaft and Przibram are explained by Brownian movements. E. E. F.

1653. *Harmonic Analysis.* **C. A. Pierce** and **W. Anderson.** (Electrical World, 58. pp. 1007–1009, Oct. 21, 1911.)—The authors make a comparison between the Fischer-Hinnen and Runge methods of separating an alternating-current wave into its various harmonic components. They call attention to the superior accuracy of Runge's method, and give a new table suitable for the accurate analysis of a wave which contains more than two or three of the lower harmonics. The following weak points in the Fischer-Hinnen method are pointed out: If harmonics of three, five, &c., times its frequency are present, the harmonic cannot be found unless these higher harmonics be also determined. The first harmonic components cannot be determined exactly unless all of the harmonics are known. There is no easy way of determining when all of the harmonics have been obtained. To determine, even approximately, a wave that is at all complex necessitates the measuring of a great many different ordinates on the complex wave. In order to determine the first, third, fifth, and seventh harmonics, 26 different ordinates must be measured. To determine the first 18 odd harmonics no less than 518 different ordinates would have to be measured. A numerical example is worked out by both methods, and Fischer-Hinnen's is proved to be much the less accurate in practice. A. R.

1654. *Weight of a Falling Drop and the Laws of Tate.* IX. *Drop-weights of Water, Ethyl and Methyl Alcohol, and Acetic Acid; and the Surface Tensions and Capillary Constants calculated from them.* **J. L. R. Morgan** and **A. McD. McAfee.** (Amer. Chem. Soc., Journ. 33. pp. 1275–1290, Aug., 1911.)—In continuation of previous work, the authors have determined the drop-weights of the above liquids at various temperatures; from these, equations have been calculated giving the surface tensions and capillary constants. In each case it is shown that the value of the critical temperature calculated from the equation $w\,(\mathrm{M}/d)^{2/3} = k_{\mathrm{B}}\,(t_c - t - 6)$, where k_{B} is a constant found by means of a similar equation for benzene, does not remain constant, but increases with a rise in the temperature of observation. These liquids, therefore, according to that definition, are not normal, but associated. The authors again emphasise that the drop-weight method is the best method for determining the surface tension of a liquid. A. F.

1655. *Earthquakes and Luminous Phenomena.* **I. Galli.** (Bolletina della Soc. Sismologica Italiana, Vol. 14, Nos. 6, 7, 8. Abstract by J. Milne in Nature, 87. p. 16, July 6, 1911.)—The original paper gives illustrations and descriptions of luminous phenomena recorded as accompanying earthquakes from 89 B.C. to 1910. For a long time past it has been known that earthquakes have been associated with special displays of aurora, fireballs, lightning, emanations from the soil, &c., but this compilation is the first attempt at a complete classification. The present reviewer refers to experiments made in Japan and in the Isle of Wight, showing that luminosity capable of affecting photographic paper is at irregular intervals emitted from the face of chalk cliffs. The effects obtained were not radio-active, and might be electrical. Mention is made of the possible effects resultant on the shearing stresses produced when masses of rock 100 miles square are suddenly dislocated.

C. P. B.

1656. *Gravity Determinations in the United States.* **W. Bowie.** (Amer. Journ. Sci. 32. pp. 101–118, Aug., 1911. Paper read before the Philosoph. Soc. of Washington, May 6, 1911.)—This paper gives a summary of the gravity determination work of the Coast and Geodetic Survey during the past few years, dealing specially with the instruments and field-work methods, reduction and discussion of the observations. One of the most important features of the analysis is the application by Hayford of Pratt's hypothesis of "*isostasy*," which is found to agree well with the results of the Survey.

C. P. B.

1657. *Determination of Seismic Centres.* **B. Galitzin.** (Acad. Sci. St. Pétersbourg, Bull. 18. pp. 941–957, Oct. 1, 1911.)—The author explains a modification of his former method of determining the position of the epicentre from observations at a single station [see Abstract No. 20 (1910)]. Instead of two aperiodic horizontal pendulums, he suggests the employment of two seismographs of identical free periods. A formula is given for the determination of the azimuth angle of the seismic waves from the throws of the two pendulums, and the epicentral distance is obtained as usual from the time by which the first phase waves have outrun the second phase. Numerous examples are given of the results obtained by an application of the method.

A. D. R.

1658. *Xenon Estimation and its Percentage in Natural Gases.* **C. Moureu** and **A. Lepape.** (Comptes Rendus, 153. pp. 740–743, Oct. 16, 1911.)—The intensity of the blue xenon line 4671·42 increases with the percentage of Xe in a gas mixture, and Xe can quantitatively be estimated like Kr [see Abstract No. 608 (1911)] with the aid of standard tubes containing A and Xe, the latter in increasing proportion; the method is reliable for mixtures containing $1{\cdot}2 \times 10^{-7}$ part by volume or 4×10^{-7} part by weight of Xe. Analyses of the natural gases from 18 springs show that the ratios Xe/A and Xe/Kr are fairly constant, the former ranging from 1·2 to 2·5 and the latter from 0·9 to 1·6, the ratio of the respective gases in air being in both cases taken as unit. Thus the constancy in the simultaneous occurrence of nitrogen and the rare, inert gases [see Abstract No. 1091 (1911)] holds also for xenon. H. B.

1659. *New Methods in Fundamental Astronomy.* **W. E. Cooke.** (Observatory, No. 440. pp. 366–370, Oct., 1911.)—As modifications of existing procedure it is proposed to employ the following method of observation involving a set of 360 equatorial stars to be selected, to which all measurements of R.A. are to be referred. Certain of these standard stars would have as small declination as possible, and the exact distances between each pair are to be determined rigidly with the transit circle. Taking the positions of these primary standards for correction of clock error, the remainder of the 36 stars are to be observed as usual with the transit, or the equatorial method might also be employed. These 360 equatorial standards would then form the basis for all time-determinations, so that the errors due to the uncertainty of clock rate over a long period of time would be eliminated. For declinations a modification of Chandler's almucantar method is advocated, combined with a few meridian transits of the standard equatorial stars. It is rather cumbersome, but eliminates errors due to refraction, flexure, and graduation.

C. P. B.

1660. *Motion of Calcium Vapour over Sun-spots.* **C. E. St. John.** (Astrophys. Journ. 34. pp. 57–78, July, and pp. 131–158, Sept., 1911. Contribution from the Mt. Wilson Solar Observatory, No. 54.)—In a former paper [Abstract No. 1579 (1910)] the investigation was confined to regions on the solar disc which were free from spots and faculæ. The combined results showed a descending motion of the absorbing vapour of 1·14 km. per sec., and an ascending motion for the emitting vapour of 1·97 km. per sec. The present paper extends the inquiry over the regions of spot umbræ and penumbræ, flocculi and circumfloccular regions. Of 25 spots examined, 22 showed at all times a downward movement of the vapour producing the bright K line of Ca. In the penumbra the Ca vapour appears to be neither ascending nor descending. In 9 cases out of 10 the results show a descent of high-level Ca vapour in the regions surrounding the faculæ. A very important feature brought out by the investigation is the occurrence at times, of detached reversals lying on the bright VK_2, suggesting the presence of detached calcium clouds rising with great velocity. The general results are not in favour of the tree-like configuration of flocculi which has several times been suggested by various observers. In the great majority of sun-spots the Ca vapour is descending with velocities varying from 0·68 km. to 2·2 km. per sec. Occasionally the Ca vapour is rising in the umbræ. Over the penumbræ of spots the Ca vapour giving out the bright line K_2 has little, if any, vertical motion. Over flocculi surrounding spots the emitting vapour shows a very slight but doubtful upward motion. Over circumfloccular regions the upper layer of absorbing Ca vapour is descending with practically the same mean velocity as over the general disc, showing no evidence of a local circulation. A radial motion of the Ca vapour inward across the penumbra is shown both by the emitting and absorbing vapour, the velocity being higher for the absorbing medium. At times a rotary motion is evident. The result of these radial and rotary motions produces a spiral or vortical motion converging upon the umbra, the direction of rotation not depending on whether the spot is north or south of the equator. The intensity of the bright K_2 line over flocculi is less than that of the continuous spectrum, and the relative intensities of K_1, K_2, and K_3 lines may be explained by the great differences in their radiation coefficients and the consequent different depths in the solar atmosphere from which light of their respective wave-lengths reaches the surface owing to selective absorption. C. P. B.

1661. *Red Spot on Jupiter.* **T. E. R. Phillips, A. S. Williams.** (Observatory, No. 437. pp. 270–272, July, 1911.)—Recent measurements of the longitude of the Great Red Spot on Jupiter indicate an acceleration of its motion, probably beginning about Feb., 1910, and continuing until May, 1911. The rotation period was about 9h. 55m. 36·5s.—much less than anything recorded during recent years. There appears to be evidence that a similar occurrence took place in 1881. The actual observations appear to have been made on the hollow in which the Red Spot lies. C. P. B.

1662. *Photographs of Mars through Coloured Screens.* **Tikhoff.** (Mitt. der. Nikolai-Hauptsternwarte zu Pulkowo, No. 42. Nature, 87. p. 529, Oct. 19, 1911. Abstract.)—Photographs of the planet Mars taken with the 30-in. refractor through differently coloured screens show differences in the intensity of the surface markings. With the red screens the continents show up very bright, while with the green screens the polar caps are the most distinctive features. C. P. B.

1663. *Spectrum of Comet Morehouse.* **A. de la Baume Pluvinel** and **F. Baldet.** (Astrophys. Journ. 34. pp. 89–104, Sept., 1911.)—In a previous communication attention had been drawn to the suitability of the objective-prism method to the investigation of cometary spectra [Abstract No. 1882 (1908)]. For this comet three different instruments have been employed: (1) A portrait lens 0·08 m. diam., 0·80 m. focal length, with a prism of 20° 18′ angle. (2) The same lens with a prism of 60° angle, giving a spectrum 10·9 mm. long between H_β and H_ϵ. (3) For studying the ultra-violet region a lens of quartz 0·06 m. diam. and 0·87 m. focal length, with an Iceland spar prism of 60° angle. In the spectra obtained 21 doublets have been detected, the wave-lengths of which are found to obey Deslandres' law. Tables are given showing the computed and observed wave-lengths, and plates given showing the coincidences with lines in the spectra of cyanogen, CO, nitrogen, carbon. A few lines of unknown origin are left outstanding. Cyanogen and carbon were present only in the head, while CO and nitrogen were found to occur in all parts of the comet. C. P. B.

1664. *Variation of the Spectroscopic Binary κ Pavonis.* **A. W. Roberts.** (Astrophys. Journ. 34. pp. 164–171, Sept., 1911.)—The variation of this star has been under investigation since the announcement of its binary character by Wright [Abstract No. 88 (1905)]. The striking feature of the resulting light-curve is what appears to be a secondary phase, nearly midway between principal minimum and principal maximum, suggesting an eclipse as the cause of variability. It is thought that the central component is larger, darker, and more massive than the satellite, and that the rotation and revolution of both stars are not synchronous. C. P. B.

1665. *Eclipsing Variable Stars.* **J. Stebbins.** (Astrophys. Journ. 34. pp. 105–111, Sept., 1911.)—Including in the term "eclipsing variables" all stars of the *Algol* or *β Lyræ* types, an analysis is made of the relationship thought to exist between the type of variability and density of the components. In general those systems appearing as eclipsing variables are of low density compared with the sun, and those of the Algol type show a strong tendency to aggregate near the Galaxy, a feature common to the stars of the first type. β Aurigæ and δ Orionis are examples given of those systems.
C. P. B.

1666. *New Bright Variable Star, β Aurigæ.* **J. Stebbins.** (Astrophys. Journ. 34. pp. 112–130, Sept., 1911.)—This star, β Aurigæ, has long been known as a short-period spectroscopic binary with a period of 3·96 days. During Oct., 1910, photometric observations indicated a change of magnitude of 0·07. This furnishes a most interesting case of an eclipsing variable star with the spectra of both components visible, and for which there are reliable measures of parallax. It was decided to determine the best possible light-curve of the system, so that accurate determinations of the diameters of the component stars, and also their surface light-intensity, could be made. The work was carried out with the selenium photometer [Abstract No. 208 (1911)], and the results are given for comparison of masses and surface brightness. The intrinsic brightness per unit area is found to be many times that of the sun. C. P. B.

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1667. *Distortion of Masonry Works.* **K. Scheel.** (Astronom. Nachr. 189. No. 4525. pp. 230–234, Sept., 1911. Communication from the Physikal.-Techn. Reichsanstalt.)—The results are given of a long series of tests of the extension distortion produced in masonry works on sloping foundations, with various cements as binding material. The tests extend over about six years. C. P. B.

1668. *Energy and Mass.* **J. D. van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 239–255, Oct. 26, 1911.)—A theoretical discussion of energy and mass from the point of view of mass being a variable dependent upon velocity. By certain assumptions the Lorentz formula is obtained. E. H. B.

1669. *Summary of the Free Air Data at Mount Weather for the Three Years July 1, 1907, to June 30, 1910.* **W. R. Blair.** (Mount Weather Observatory, Bull. 4. pp. 25–102, 1911.)

1670. *Spectrum of P Cygni.* **P. Merrill.** (Lick Observatory, Bull. No. 201. Nature, 87. p. 563, Oct. 26, 1911. Abstract.)—It is found that the lines due to silicon are differentially displaced towards the red by about 0·26 Å. C. P. B.

LIGHT.

1671. *Recomposition of Light.* **A. Amerio.** (N. Cimento, 2. Ser. 6. pp. 80–82, July, 1911.)—Newton's colour disc may be improved upon by imparting a vibratory or rotatory motion to the prism. Those portions of the screen over which all the colours pass in succession will appear white. Or a mirror is mounted on a shaft in such a manner that its normal makes an angle of a few degrees with the axis of rotation. The spectrum falls upon the mirror in the direction of the axis of rotation and is reflected on to a screen. When the shaft rotates, the colours will be variously mingled, and white will be obtained in certain parts of the screen. E. E. F.

1672. *Light Absorption by Fluorescein.* **F. Kaempf.** (Phys. Zeitschr. 12. pp. 761–763, Sept. 15, 1911.)—Light is passed through fluorescein both when it is rendered fluorescent by another source of light and when it is not, and the intensities of the transmitted light are compared. No change in the intensity of the transmitted light is caused by the fluorescence—a result which is the opposite of that found by some other investigators. Lambert's law, which states that the absorption is independent of the intensity of the incident light, is found to be true for fluorescein. T. P. B.

1673. *Group Velocity in Dispersion.* **U. Cisotti.** (R. Ist. Lombardo, Rendiconti, 44. Ser. 2. 1911. N. Cimento, 2. Ser. 6. pp. 234–244, Sept., 1911.)—In connection with Abraham's electrodynamic version of a theorem of Reynolds, the author points out that the actual electric displacement D at a given time depends not only on the actual electric force E, but upon its whole previous history, and so does B upon previous values of H. It therefore becomes necessary to study the influence of linear "heredity" upon the behaviour of energy. When this is taken into consideration, it appears that the medium does not act as a purely dispersive medium. [To this Abraham replies that no medium does act purely dispersively to all radiations.] In the present note the author proves that "hereditary" phenomena are not reversible in time. Reversibility in time is taken to mean the property by which, if $E(t)$ and $H(t)$ are electromagnetic forces satisfying the infinite equations of the field, the same equations will also be satisfied by $E(-t)$ and $-H(-t)$, or by $-E(-t)$ and $H(-t)$. E. E. F.

1674. *Light-scattering in the Region of Wien's Interference, and New Reciprocal Interference Phenomena.* **P. Selényi.** (Ann. d. Physik, 35. 3. pp. 444–460, July 11, 1911.)—Describes experiments in which scattering of light occurs from the fine particles of a precipitate in the region of Wien's interference phenomena. And then, reciprocally, interference phenomena are obtained by the light scattered from such particles, although the rays received direct from the particles are at a large angle (up to 100°) with those which fall on the mirror and are received thence after reflection parallel to the direct rays and interfering with them. E. H. B.

1675. *New Interference Phenomenon with Parallel Light.* **H. Schulz.** (Phys. Zeitschr. 12. pp. 306–310, April 15, 1911.)—An isosceles prism is used in conjunction with a plane mirror, giving a single axis of symmetry coincident with the principal section of the prism, and the position of the extreme point of the path-difference is dependent on the wave-length. The prism ABC, the faces AB and BC being equal, is placed with the angle B near the plane mirror, which is parallel to AC. A ray incident on the face AB is partly reflected towards the mirror and part enters the prism, being reflected from the face AC and emerging from BC. The reflected portion strikes the mirror where the plane through the edge B perpendicular to AC meets the mirror, is reflected there and again from the face BC, the two rays leaving BC thus being parallel. The path-difference of the two rays depends on the angle of incidence ω of the ray on the face AB. If a is the distance between B and the mirror, h the distance from B to AC, a table is given showing the values of a/h, ω, ρ and n (the refractive index of the prism), ρ being half the angle B, for values of n from 1·50 to 1·54. The theory of the effect is given, and also an experimental test of the conclusions deduced. A. W.

1676. *Interference Strioscopy and Striography analogous to the Optical Method of Striæ by Foucault and by Töpler.* **G. Sagnac.** (Le Radium, 8. pp. 241–253, July, 1911. Comptes Rendus, 153. pp. 90–93, July 10, 1911. Errata, ibid. p. 312, July 24, 1911.)—The method of Foucault generalised by Töpler under the name of the method of striæ (Schlierenmethode), was modified or applied by Dvorak, E. Mach and L. Mach, Wood, and Tanakadate. It projected on to a dark background the bright image of the region which is the seat of a deviation of the light, as a column of hot air. The explanation of how this principle is applied to interference phenomena then follows, but refers to diagrams in a previous paper [Abstract No. 1418 (1910)]. Three arrangements are treated, viz.: (1) The superposition of beams; (2) Instantaneous electric sparks; (3) Two or four mirrors. E. H. B.

1677. *The Pupil of an Optical System with regard to Perspective.* **C. Beck.** (Roy. Soc., Proc. Ser. A. 85. pp. 462–470, Aug. 15, 1911.)—Hitherto the use made of the so-called "entrance and exit pupil" of an optical system has been chiefly in regard to aperture and the questions which are related thereto. The author has investigated the conception more completely, and found that it may be used with advantage as an additional factor, in connection with the Gauss planes, for explaining the action of optical instruments as regards the perspective of the images formed. The entrance and exit pupils are the equivalent apertures of the optical system, and their service is therefore analogous to that of the equivalent planes and equivalent foci of the Gauss system. By assigning the correct position to these two apertures or pupils we can investigate the perspective of an image without taking further consideration of the system itself; just as by assigning the correct position to the two Gauss planes we can investigate the size and position of the images irrespective of the system itself. The Gauss equivalent lens tells us the size and position of the image formed. The "pupils" determine what rays form the image, and they further determine the perspective, without invalidating the results given by the Gauss system as to the positions and sizes of the focussed images. A full explanation of this is given, and formulæ are deduced from which a very simple geometrical construction can be derived for showing the position, in the object-space of an optical system, of a line which is conjugate to any given line in the image space. A convenient method of expressing the perspective of a photograph is by defining the distance from the eye at which it should be held in order to give on the retina an image in which the proportions of the parts are in the same perspective as is seen by the eye at the standpoint from which the object was photographed, *i.e.*, to define the position of the projection centre of the photograph. One formula obtained gives the distance of the perspective centre in terms of the focal length, the position of the photographic plate, and the position of the exit pupil. It also shows that for distant objects sharply focussed the perspective centre is in the exit Gauss plane, as would be the case when the exit pupil coincides with the exit equivalent plane; but the case is different for near objects, and an anomalous perspective is produced, which is very unexpected. Suppose the equivalent focal length of the system be 9 in., and the exit pupil is displaced 5·88 in. behind the equivalent plane, then if a photograph of a distant view be taken, the photographic plate being placed in the focal plane, the perspective will be normal for objects nearly at infinity, and exactly like that taken by any other form of 9-in. lens. Hence, to obtain correct perspective, the photograph must be viewed with the eye at a distance away of 9 in., and not, as has been previously suggested, at the position of the exit pupil, which in the case chosen is at a distance of 8·17 in. Were the latter the case, no difference in perspective would be gained by the use of a telephoto lens over a short-focus instrument. If a near object is being photographed, and the plate be placed 18 in. away from the exit equivalent plane, so as to photograph objects full size, the result is remarkable, as in this case the perspective centre, instead of being 18 in. away, as would be the case with an ordinary lens, or being 12·17 in. away if the exit pupil were the projective centre, is 35½ in. away, and the perspective is greatly reduced by the use of such a lens. If the object is photographed half-size, the perspective centre is 22 in. instead of 18½ in. This explains an interesting point in the practical use of telephoto lenses. For distant views the perspective will, on the whole, give the effect produced by photographing with an ordinary lens of about the same focal length as the equivalent focal length of the telephoto system. But if a telephoto lens be used for near objects, as, for instance, for full-size portraits, the perspective of a 9-in. lens, with exit pupil in the position shown in the diagram given, will give the perspective effect produced by an ordinary lens of 17½-in. focus; or, if half full-size, of a lens 14½-in. focus. This accounts for the pleasing portraits obtained by the use of the telephoto lens. For all purposes, except extreme distance, the perspective foreshortening in a photograph taken with a telephoto lens is less pronounced than would be expected from a lens of that focal length. Actual photographs of the interior of a long square-section tube illustrate this. A. W.

1678. *Energy Distribution of Long-wave Radiation from Quartz Mercury Lamp.* **H. Rubens** and **O. v. Baeyer.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 30. pp. 666–677, 1911.)—The process of isolating the long-wave radiation from the quartz mercury lamp has previously been described [Abstract No. 866 (1911)]. Rubens and Wood's quartz lens apparatus was employed [Abstract No. 220 (1911)]. The positions of the principal maxima were not determined with great accuracy, on account of the non-homogeneity of the radiation and the fewness of the observations. In the present research much better conditions were secured and reliable measurements made of the distribution of energy. A higher voltage (188 volts) was employed across the lamp terminals, giving a 20 per cent. increase of emission. The quartz lens arrangement was also modified slightly, the distance between the interferometer and the lenses being made greater than that between the lens and lamp. With the improved arrangements better results were obtained. It was found that the energy distribution curve varies with the substance through which the rays pass. Curves are given (i) for the unfiltered radiation, (ii) for the radiation filtered through 2 mm. of amorphous quartz, (iii) for the radiation filtered through black cardboard 0·4 mm. thick. The curves show two maxima, one at 218 μ and the other at 343 μ. For the unfiltered radiation the first of these maxima is about double the latter; filtered through amorphous quartz the first maxima is only slightly higher than the second, but filtered through black cardboard the first maximum is the smaller of the two. A table is given showing the comparative transparencies of amorphous quartz and black cardboard for the long-wave radiation from a mercury lamp, an amalgam lamp, a cadmium lamp, and also the light from amorphous quartz heated in a Bunsen flame. The question as to whether the long-wave radiation of mercury vapour is to be considered as a luminescence radiation or as a temperature radiation cannot at present be decided. A. W.

1679. *Polarisation of Light by Gratings.* **J. Koenigsberger.** (Phys. Zeitschr. 12. pp. 687–689, Aug. 1, 1911.)—Hertz found that electromagnetic waves are polarised if they are passed through a grating whose dimensions are small compared with the wave-length. The author shows here that by using a grating with a very small constant, light waves may also be polarised. Using the processes employed in Lippmann's colour photography, a grating was constructed with sub-microscopic grating structure, the grating constant finally reached being about 0·22 μ. This grating gives marked polarisation with ordinary light. [See also Abstract No. 1696 (1911).] A. W.

1680. *Measurement of Luminosity of the Spectrum.* **F. Allen.** (Phil. Mag. 21. pp. 604–607, May, 1911.)—A periodically interrupted ray of light entering the eye produces a sensation of flickering until the interruptions reach a certain critical frequency at which the impressions of the separate flashes of light become fused into one continuous sensation. Ferry, and also Porter [Abstracts Nos. 1318 (1898), and 209 (1908)] discovered that the duration of the sensation of undiminished brightness of a flash of light, at the critical frequency of interruption, depended only on the luminosity of the light and not in any way on the colour. The duration of the impression was found by both investigators to be inversely proportional to the logarithm of the luminosity of the light. A method, based on the above, of measuring the luminosity of the spectrum is given in the present paper. Light from an acetylene flame passed through an open sector of a disc (D) rotated by an electric motor, then through two Nicol prisms (E and F) arranged with their principal sections horizontal, thence through a spectrometer, and was finally viewed in a Hilger eyepiece in which all the light of the spectrum, except a narrow central band of any desired colour, was shut off by means of adjustable shutters. In front of the disc D a small mirror was fixed so as to reflect white light to a similar mirror, mounted on the eyepiece, which reflected it down through a hole in the eyepiece upon the polished sloping top of a steel pointer, which finally reflected the light to the eye. The observer, therefore, could see a small patch of white light, and immediately above it a patch, of suitable size, of any desired colour of the spectrum. The white light could be reduced in intensity to any desired amount by changing the inclination of the mirrors, while the intensity of the spectrum was controlled by rotating the polariser E. When the disc was rotated both patches flickered at the same rate. In measuring the luminosity of the spectrum, the intensity of the patch of white light was first lowered until it was of the same luminosity as a patch of violet ($\lambda = 0{\cdot}414\,\mu$) of undiminished brightness (the nicols having their principal sections parallel) and as near the end of the spectrum as it was possible to make measurements upon. The intensities of the white and violet lights were considered equal when the critical frequency of flicker was the same for both. The white light now became the standard of comparison, and was maintained continuously at this low intensity through all the observations. Each selected part of the spectrum was in turn brought into view and reduced to the luminosity of the white patch by rotating the polariser an amount depending on the brightness of the spectrum under observation. The luminosity of each part of the spectrum is inversely proportional to the intensity of the portion of light passing through the nicols, which is proportional to $\cos^2 a$, a being the angle between the principal sections of the nicols. A table is given showing the variation of luminosity with wavelength; the corresponding graph gives a maximum for $\lambda = 0{\cdot}598\,\mu$. A. W.

1681. *Enclosed Arc for Spectroscopic Work.* **J. Barnes.** (Astrophys. Journ. 34. pp. 154–158, Sept., 1911.)—Description of an apparatus for working an electric arc under reduced pressure. A strong glass bell-jar is provided with inlet and exit tubes, and firmly cemented to a metal base-plate. The electrodes are provided with adjustable pole-pieces of different metals, and for striking the arc either an external electromagnet or the discharge from an induction coil is used. C. P. B.

1682. *Metallic Spectra under Reduced Pressure.* **J. Barnes.** (Astrophys. Journ. 34. pp. 159–163, Sept., 1911.)—Considerable attention has been devoted to the investigation of the spectra of metals *in vacuo* [Abstracts Nos. 2877 (1904), 1208 (1905), 779 (1908), 101 (1910), and preceding Abstract]. The present paper gives details of the spectra of Al, Cu, and Mg in the arc under reduced pressures. The general effect is to increase the intensity of the spark lines of Al and Mg, and to diminish many of the arc lines of Cu.
C. P. B.

1683. *Fluorescence of the Vapours of the Alkaline Metals.* **L. Dunoyer.** (Comptes Rendus, 153. pp. 333–336, July 31, 1911.)—The preliminary researches have been principally carried out on the fluorescence spectrum of Rb, and on the polarisation of the light emitted by the vapours of Na, K, and fluorescent Rb. It was hoped that cæsium, whose volatility is much greater than that of the other alkaline metals, and whose absorption spectrum has the same characters, would give at low temperatures a brilliant fluorescence. But at 350°, at which temperature the vapours of the other three metals are already very fluorescent, only a very feeble fluorescence was obtained with Cs—too feeble to be investigated with the author's apparatus. This fluorescence appeared to be violet-rose. The metals were treated in glass tubes by distillation *in vacuo*. The tubes were sealed at a pressure of 0·0001 mm. of mercury. With Na the fluted spectrum, green, commences to appear about 290° C., but the D line can appear in certain conditions at about 210° C. With rigorously pure Na in a perfectly evacuated tube, the fluorescence is not green, but a clear yellow. This effect is discussed in the light of Wood's researches. The purple fluorescence of potassium vapour commences to appear about 215° C. It increases rapidly in brightness and becomes extremely brilliant about 320° C. Its spectrum has been studied, in a steel tube, by Wood and Carter. The vapour of Rb commences to become fluorescent about 180° C. It is reddish-purple and much resembles that of potassium.

The fluorescence of Cs appears about 850° C. But above this temperature it increases slowly, while the glass rapidly becomes brown. The temperature variation of the fluorescence of Rb is dealt with at some length. Wood has previously observed the polarisation of the light emitted by fluorescent Na. The author has studied the manner in which the polarisation of the fluorescence of the three metals (Na, K, Rb) varies with temperature in the given conditions. The following are the results obtained: (i) The curves which connect the partial polarisation and the temperature have the same character for a given metal, whether the exciting light is polarised or not. When the incident electric vector is in the plane defined by the incident and observed ray, the polarisation is null. (ii) The polarisation as a whole, as Wood has observed, diminishes as the temperature rises. While the curves obtained for Rb present a slight minimum about 870°, the curves for Na and K give a slight maximum at a much lower temperature. The former have their concavity upwards and the latter downwards. (iii) When the exciting light is not polarised, the polarisation is sensibly the half of that when the electric vector is perpendicular to the plane of observation. It is of the order of 19 per cent. in the first case and of 87 and 88 per cent. in the second. These values are higher than those found by Wood. (iv) The depolarising cause appears to be a mutual action, due to temperature, of the fluorescent molecules. For, if the vapour is not saturated the polarisation is much stronger than if the vapour is saturated, *i.e.*, if there is an excess of metal in the tube. But it is an action exerted between the fluorescent molecules alone, for Wood has obtained no change of polarisation on introducing into his tube nitrogen at a pressure of several mm. A. W.

1684. *Disintegration Products of Uranium.* **G. N. Antonoff.** (Phil. Mag. 22. pp. 419–432, Sept., 1911.)—Uranium X was separated from Ur by adding an iron salt to the solution and precipitating by boiling. The decay of the UrX separated in this way was examined (1) for the whole of the radiations; (2) for the harder rays which had passed through 0·01 cm. Al. It was found that in the initial stages the decay curve of the former was quicker than that of the latter, the difference indicating a product of period 1·5 days. The author was not able to separate the product from UrX but by first separating them together from Ur and then making a second separation after 4 days, when very little of the UrX had grown while the new product UrY was nearly in equilibrium, it was found possible to obtain a substance fairly rich in the new product. It was found to emit soft β-rays with an absorption coefficient $\mu = 800(\text{cm.})^{-1}$, and probably also a few α-rays, the number of the latter being small in comparison with that to be expected from the β-ray activity. However, from a given quantity of Ur only a very small quantity of UrY could be separated, the activity being only of the order 1/60,000 of the total electrical effect of the Ur, showing that UrY is not the explanation of the two α-particles which are known to be given off from Ur. Again, no evidence could be obtained that the new product is either transformed into UrX or is produced by transformation of the latter. The author therefore concludes that UrY is a branch product of Ur. Details are given in the paper of the elaborate methods employed in the purification of the Ur, in order to remove all radio-active impurities. E. M.

1685. *Balloon Measurements of Penetrating Radiation.* **A. Gockel.** (Phys. Zeitschr. 12. pp. 595–597, July 15, 1911.)—The author has previously given results of measurements of the penetrating radiation of the atmosphere made on a balloon voyage [Abstract No. 958 (1910)]; these results showed that the penetrating radiation of the atmosphere only decreased slightly with the height, but the results were not free from objection. But measurements carefully taken on two subsequent balloon voyages have confirmed the results previously obtained. The first voyage was made on Oct. 15, 1910, from Zürich to a point between Olten and Solothurn. The max. height reached was 2860 m., and the volt loss per hour of the Wulf apparatus used varied from 18·3 at the start to 8·8 at 1700 m., 10·0 at 2800 m., and 9·8 after landing. The mean value for the loss per hour at Freiburg the day before and the day after the voyage was 10·8 volts. The second journey was on April 2, 1911, starting from Bern. The capacity of the apparatus had been altered slightly from 1·2 cm. to 1·8 cm., so that 1 volt per hour corresponded to 1·20 × 10^{-6} e.s. unit. The greatest height reached was 2800 m. The volt loss per hour varied from 15·8 before starting to 18·8 at 1600 m., 15·1 at 1900 m., and 12·2 at 2500 m. The mean volt loss the day before the journey was 18·8, and the day following, after heavy thunder rain, 12·5. On both journeys the temperature variation was small. Hence it seems that the variation in the penetrating radiation is, as Wulf also found, only local and temporary. [See also Abstract No. 670 (1909).] A. W.

1686. *Radio-activity of Soil.* **J. C. Sanderson.** (Amer. Journ. Sci. 32. pp. 169–184, Sept., 1911.)—The present experiments deal with the amounts of Ra and Th emanations given off by the soil. Air was drawn through a small iron vessel buried about 120 cm. below the surface of the ground (New Haven) and conducted directly into an electroscope. From the rise curve of activity on starting the air-current, and the decay curves when stopping it under various conditions, an estimate of its radio-active constituents was obtained. It was found that 1 c.cm. of this underground air contains RaEm equal to the amount in equilibrium with 2·4 × 10^{-13} gm. Ra, this being equivalent to the production, per c.cm. of earth, of RaEm in equilibrium with 8·9 × 10^{-14} gm. Ra. The soil examined was found to contain per c.cm. of volume an amount of ThEm equivalent to that produced by 1·8 × 10^{-6} gm. Th under the best condition of emanating power which could be obtained. This latter emanating condition was obtained by intimately mixing a dilute solution of 0·1 gm. thorite with 884 gm. of white beach sand. This mixture was thoroughly dried, moistened with 12 c.cm. of water, and placed in a tin cylinder, measurements being made by sucking air through it. [See Abstract No. 1504 (1911).] E. M.

REFERENCES.

1687. *Glass Polarisation Prism.* **H. Schulz.** (Zeitschr. Instrumentenk. 31. pp. 180–183, June, 1911.)—Describes a new form of polarising prism. It is shown that the polarising prism devised by Stolze gives an asymmetrically polarised beam, and the amount of polarisation falls off quickly. With the new type of prism the polarisation is, at least for divergence of ± 10°, symmetrical about the central beam, and the amount of polarisation falls off much slower as the angle with the central beam increases. A. W.

1688. *Refractive Indices of Liquid Crystals.* **P. Gaubert.** (Comptes Rendus, 153. pp. 573–576, Sept. 18, 1911.)—Data are given for the refractive indices of the two rays for the propionate, benzoate, acetate, and caproate of cholesterin, and for a series of 7 mixtures of liquid crystalline substances. T. M. L.

1689. *Photochemical Effect of Ultra-violet Light.* **C. Schall.** (Zeitschr. wiss. Phot. 10. pp. 89-116, Sept., 1911.)—A continuation of the author's work previously dealt with [Abstracts Nos. 1348 and 1522 (1910)] on the blue colouration of *p*-phenylenediamine nitrate paper exposed to ultra-violet light. A photometric investigation is given of the relation between the colouring and the light intensity. A. W.

1690. *New Interference Curves.* **E. Waetzmann** and **O. Lummer.** (Ann. d. Physik, 36. 2. pp. 383-394, Oct. 19, 1911.)—Describes and discusses the interference curves (ellipses and hyperbolæ) visible with a Michelson interferometer from which the compensation plate has been removed, one of the two mirrors being shifted parallel to itself and the telescope being focussed at *infinity*. E. H. B.

1691. *Michelson's Interference Experiment.* **E. Riecke.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 3. pp. 271-277, 1911.)—Deals with the theory of this experiment on the basis of the relativity principle. E. H. B.

1692. *Elliptic and other Interference with Reflecting Gratings.* **C. Barus.** (Phil. Mag. 22. pp. 118-129, July, 1911. Abstract of Report to the Carnegie Inst. of Washington.)

1693. *Photometric Measurement of the Obliquity Factor of Diffraction.* **C. V. Raman.** (Phil. Mag. 21. pp. 618-626, May, 1911.)—Gives the results of quantitative measurements of the effects previously described [Abstract No. 482 (1909)].

1694. *Anomalous Magnetic Rotation and Selective Absorption.* **G. J. Elias.** (Ann. d. Physik, 35. 2. pp. 299-346, June 29, 1911.)—An investigation, by the half-shadow method, of the magnetic rotation and absorption of solutions of a number of the rare-earths; also liquid air and uranium glass. The results are given in curves and tables. L. H. W.

1695. *Hartman-Cornu Reduction Formula for Spectrograms.* **F. J. M. Stratton.** (Roy. Astronom. Soc., M.N. 71. pp. 663-670, June, 1911.)—The usual Hartman-Cornu reduction is modified by utilising more than three fiducial lines in the computation of the formula constants. Examples are given, showing that the new method gives results of similar accuracy to the original, but with the advantage of greater rapidity in computation when several plates of spectra have to be treated. It should be specially useful in the reduction of spectrograms for radial velocities with objective prisms and single-line light filters. C. P. B.

1696. *Polarisation of Long-wave Heat Rays by Means of a Wire Grating.* **H. du Bois** and **H. Rubens.** (Ann. d. Physik, 35. 2. pp. 243-276, June 29, 1911. Phil. Mag. 22. pp. 322-342, Aug., 1911.)—The research deals with wave-lengths between 24 and 108 μ, including the "Reststrahlen" from fluorite and from rock-salt, and the long-wave radiation from the Auer mantle, isolated with the quartz-lens apparatus previously described [Abstracts Nos. 220 and 866 (1911)]. In addition, measurements were made with the long-wave radiation (mean wave-length about 314 μ) of the quartz mercury lamp. Tables are given of the results obtained with various metal wire gratings. These are illustrated graphically and discussed, the curves obtained falling into four groups. A brief abstract of the results cannot be given. A. W.

HEAT.

1697. *New Method of reducing Heat-rays in Projection Apparatus.* **G. Leimbach.** (Phys. Zeitschr. 12. pp. 791–798, Oct. 1, 1911.)—Schulze found that a wire gauze placed between the condensing lenses of a projection apparatus reduced the heat effect of the emergent beam more than it weakened the light intensity. Various types of grating were employed in the author's investigation of this effect, some gratings being of glass and others of wire. A theoretical treatment is given, and the effect of variation of the grating constant is dealt with. The results are tabulated and illustrated by graphs. A. W.

1698. *Specific Heats at Low Temperatures. Copper Calorimeter.* **F. Koref.** (Ann. d. Physik, 36. 1. pp. 49–73, Oct. 3, 1911.)—The previously described copper calorimeter of Nernst and F. A. Lindemann [see Abstract No. 821 (1910)] has been modified slightly for determining the specific heats at low temperatures, over the interval — 180° (liquid air) and — 80° C. (solid CO_2), and other intervals. The substance is brought to the initial temperature within a silver cup, placed in a vacuum tube of quartz or glass ; this cup fits exactly into the copper calorimeter, and the transference of the cup into the calorimeter takes 3 sec., a full experiment 20 to 30 min. The results are considered accurate within at least 1 per cent. The new and previous determinations concern 48 substances, comprising Al, Cu, Pb, Zn, Hg (liquid and solid), the alkali metals, diamond, boron, Acheson graphite, sulphur, Ca, CaO, $Ca(OH)_2$, quartz (amorphous and crystalline), glass, many salts, ice, paraffin, petrol. The apparatus is also suitable for other thermochemical measurements, and has been used for the determination of the heat of evaporation of CS_2, 6614 cals. The results are discussed with regard to the heat theorem of Nernst and the Planck-Einstein theory of specific heat as modified by Nernst and Lindemann. H. B.

1699. *Heat of Evaporation of Water.* **A. W. Smith.** (Phys. Rev. 33. pp. 173–183, Sept., 1911.)—The steam was drawn by means of a current of air from the quiet surface of water kept constantly at 98·07°, condensing and weighing the water. The value calculated for 100° is found to be 536·7 mean cals. per gm. A. F.

1700. *Latent Heat of Vaporisation of Liquids.* **W. C. McLewis.** (Phil. Mag. 22. pp. 268–276, Aug., 1911.)—The latent heat of vaporisation L of a liquid per gm. is connected with the compressibility β and the coefficient of expansion α, of the liquid by means of the relation—

$$L = -\frac{T}{p}\frac{\alpha_1}{\beta}.$$

The applicability of this relation appears, however, to be restricted to normal liquids alone. L. H. W.

1701. *Relation of Heat of Vaporisation to other Constants at the Boiling Temperature.* **J. P. Montgomery.** (Amer. Chem. Journ. 46. pp. 298–307, Sept., 1911.)—From experimental data the author concludes that: (1) The specific volume of the vapour from a boiling liquid is proportional to the heat of vaporisation. In other words, equal quantities of heat applied to liquids at their transition temperatures produce equal volumes of vapour at these temperatures. (2) In vapours at their transition temperatures the heat of vaporisation is proportional to the square of the velocity of the molecules and the molecular kinetic energy is proportional to the absolute temperature. (3) The quantity of heat required to vaporise a unit volume of a liquid at the transition temperature is proportional to the number of molecules in a unit volume and to the absolute temperature. (4) In the case of isomers the absolute temperature of the boiling-point is proportional to the density of the liquid at the boiling-point. (5) The absolute temperature of the boiling-point is inversely proportional to the relative size of the molecules and directly proportional to the molecular weight and to the square root of the number of atoms in the molecule. Finally, the conclusion is reached that the boiling-point of a liquid is a function of size, weight, and complexity of molecules, but that heat of vaporisation is not concerned in molecular complexity, except association, or in intramolecular work. T. M. L.

1702. *The Energy-content of Solid Substances.* **W. Nernst.** (Ann. d. Physik, 36. 2. pp. 395–439, Oct. 13, 1911.)—An extension of Eucken's method [see Abstract No. 1714 (1909)] is described by means of which the true specific heats can be determined at very low temperatures. By means of liquid air specific heats were determined down to 70° abs.; with liquid air boiling under diminished pressure, to 60° abs.; with liquid hydrogen to 22° abs., and in one case, with liquid hydrogen boiling under diminished pressure, to 16° abs. In this way it was possible to determine the atomic and molecular heats of solid substances over a very wide range of temperature. In those cases where the different atoms of an element or compound have the same vibration number, ν, the following equations hold: $C_v = (3/2)R\,[(\beta\nu/T)e^{\beta\nu/T}/(e^{\beta\nu/T}-1)^2 + (\beta\nu/2T)^2\,e^{\beta\nu/2T}/(e^{\beta\nu/2T}-1)^2]$ and $C_p - C_v = ATC_p^2$; the second equation can be simplified to $C_p - C_v = aT_{3/2}$, A and a being individual constants. The energy-content W, at any, but small, pressures (*e.g.*, 1 atmo.) then becomes—

$$W = (3/2)R\,[\beta\nu/(e^{\beta\nu/T}-1) + (\beta\nu/2)/(e^{\beta\nu/2T}-1)] + (3/5)aT^{5/2},$$

and thus becomes capable of measurement. With substances in which the atoms have different individual frequencies, the diminution at low temperatures is always less than given by the above formulæ; by the introduction of several frequencies formulæ can be obtained which give results in accordance with the experimental results. Satisfactory results are obtained with one frequency only, for the following substances: Al, Cu, Ag, Pb, Hg, Zn, I, diamond, KCl, NaCl, and KBr, whereas Einstein's formula is completely at fault at low temperatures. The quanta theory of Planck and Einstein must be modified considerably to give a quantitative interpretation of the results obtained, although qualitatively it is in agreement with them. Substances in which several frequencies of the atoms had to be taken into account were sulphur, graphite, SiO_2, $PbCl_2$, AgI, HgCl, AgCl, benzene, &c. In no case were indications obtained that metals and non-metallic substances possess a characteristic difference in their energy-content, so that the modern electron theory of the metals cannot hold, especially in the cases where it is in contradiction to the experimental facts. We must assume that either the gas equation is not valid for the free electrons, or else that the number of the latter is infinitely small compared with the number of metallic atoms. The results show that the atomic heats of elements and molecular heats of compounds become vanishingly small before the absolute zero is reached, and it follows that all the properties of solids, whether crystalline or amorphous, which depend on the average behaviour of the atoms, become independent of the temperature at low temperatures. To these belong the thermodynamic functions, and it follows that the author's heat theorem is a special case of a general theorem. T. S. P.

1703. *Radiation in Explosions of Coal-gas and Air.* **W. T. David.** (Roy. Soc., Phil. Trans. 211. pp. 375–410, Oct. 20, 1911.)—In the first part of this paper the results of experiments are given on the radiation emitted during the explosion and subsequent cooling of mixtures of various strengths and densities of Cambridge coal-gas and air. Bolometric measurements were made of that part of the radiation from the hot gaseous mixtures which was transmitted through clear plates of fluorite, quartz, plate glass, and water (contained between two plates of glass). The fluorite (6 mm. thick) transmits about 95 per cent. of the total radiation emitted by the gas; the quartz (also 6 mm. thick) transmits about 70 per cent. of the radiation from the water-vapour and cuts off a very large proportion of that from CO_2; the water cell transmits practically only luminous radiation. It was therefore possible to estimate fairly accurately the total radiation emitted by the gas, and, roughly, the proportions emitted by water-vapour and by CO_2, and also the amount of energy in the luminous radiation. The radiation in the explosion of a 25 per cent. mixture of hydrogen and air was also measured. The second part of the paper consists of an investigation into the diathermancy and emissive power of the hot gaseous mixture after explosion. The conclusions drawn from these experiments offer an explanation of many of the peculiar results given in the first part. Numerous tables and diagrams are given. The experiments suggest among other things that the radiation from thicknesses of gas containing the same number of radiating molecules does not depend solely on the temperature of the gas, even after correcting the observed values of the radiation for absorption. A theoretical explanation of this is suggested, from which it appears that at any given temperature the greater the gain of vibratory energy during the free-path the greater will be the average vibratory energy of the molecule; and that, other things being the same, (i) The greater the energy density in the ether (which depends among other things upon the transparency and the volume of the gas) the greater will be the average vibratory energy of a molecule as compared with its translational energy, though, of course, the average vibratory energy of the molecule will only increase slowly with the energy density of the ether. (ii) The smaller the time of description of free-path (*i.e.*, the greater the density of the gas) the nearer will the average vibratory energy of a molecule approach a value which is proportional to the absolute temperature of the gas. The average value of the vibratory energy of the radiating molecules of a gas thus appears to be a function not only of the absolute temperature of the gas, but also of the value of the energy density of the ether, the rate at which molecules emit radiation, the time of description of free-path, and the rate of partitioning of energy during collisions. The result obtained, that the rate at which radiation is emitted by the gaseous mixture is a maximum some time before the attainment of max. pressure, shows that the vibratory energy of the radiating molecules is a maximum some time before the mean temperature of the gaseous mixture attains its max. value. B. Hopkinson's experiments show that no portion of the gaseous mixture during explosion has such a high value as at the moment of maximum pressure, so that it is very probable that the violence of combustion during explosion causes a considerable part of the energy of combination to pass into the form of internal vibrations of the CO_2 and steam molecules. Part of the energy in these vibrations is lost by radiation, but the greater part is transformed into rotational energy and translational or pressure energy. [See also Abstract No. 1462 (1910).] A. W.

1704. *Internal Pressure of Fluids and Determination of the Absolute Zero.* **E. H. Amagat.** (Comptes Rendus, 153. pp. 851–857, Nov. 6, 1911.)—The author has previously shown [Abstracts Nos. 1252 and 1253 (1909)] that $T(\partial p/\partial t) - p$, and $p_0v_0/v - p$ (both called the internal pressure and denoted by π and Π') are, once the molecular distances are sufficiently great, in the inverse ratio of the square of the volume. Leduc has recently given further experimental verifications of this law for various gases. The author considers that the variation of π, at constant volume, with temperature is small, and examines experimental evidence which at first sight seems to lead to a contrary conclusion. The intermolecular action $\phi(r)$ is inversely proportional to the fourth power of the mean intermolecular distance r. The question as to whether it varies with the square of the masses of the molecules is discussed. The necessity of modifying the term a/v^2 in van der Waals' formula, proved by Leduc's experiments, is also discussed. A. R.

REFERENCES.

1705. *Problems in the Conduction of Heat.* **Rayleigh.** (Phil. Mag. 22. pp. 381–396, Sept., 1911.)—Mathematical.

1706. *Nuclei of Cloudy Condensation.* II. **J. Aitken.** (Roy. Soc. Edinburgh, Proc. 31. pp. 478–498, 1910–1911.)—An account of some further investigations on the abnormal dust readings at Kingairloch.

1707. *Calculation of Specific Heats.* **W. Nernst** and **F. A. Lindemann.** (Zeitschr. Elektrochem. 17. pp. 817–827, Sept. 15, 1911.)—Einstein's somewhat complex exponential formula for atomic heats is recast in a more elaborate form, and is then shown to agree with the authors' recent measurements at temperatures down to 23° abs. T. M. L.

1708. *Radiation Hypotheses.* **P. Ehrenfest.** (Ann. d. Physik, 36. 1. pp. 91–118, Oct. 3, 1911.)—Discusses the question as to what feature of the light-quantum hypothesis plays an essential part in the theory of heat radiation. E. H. B.

1709. *Heat Radiation and Conduction.* **J. Suchý.** (Ann. d. Physik, 36. 2. pp. 341–382, Oct. 13, 1911.)—A mathematical treatment of the subject; does not admit of brief abstract. [See also Abstracts Nos. 1452 (1900) and 1207 (1903).] A. W.

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ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

1710. *Simple Proof of Poynting's Theorem.* **J. F. H. Douglas.** (Phys. Rev. 33. pp. 322–324, Oct., 1911.)—Poynting's theorem states the law which electrical energy follows in its flow through space. The magnetic field within any tube of magnetic force may be considered as due to a current circulating round it. This current will have the same number of amp.-turns as the current in the conductor which produces the field. Such a combination is equivalent to the original field, for the current layers when combined would neutralise one another. The element being shielded from magnetic forces, the only work done at the boundaries must be electrical work. Therefore, this must be done by virtue of the electric field. The current which circulates round each tube of force in some places flows against, and in some places flows with, the electric field. Hence in some places energy is leaving the electric circuit for the interior of the element; and on the opposite side, while flowing in the same direction, leaves the element for the electric circuit. The rest of the proof then follows simply. A. R.

1711. *Diffusion of Electrostatic Potential into the Air.* **A. Garbasso** and **G. Vacca.** (Accad. Lincei, Atti, 22. pp. 296–302, Oct. 1, 1911.)—A wooden frame 5 m. × 5·5 m., suspended vertically in the Great Hall of Geneva University, at about 1 m. from the floor, has been studded with 50 iron nails, arranged symmetrically and at right angles to its plane. The nails were then connected with a Wimshurst machine, and after the machine had been worked for a short time and stopped, the variation in potential during the next few minutes was observed by means of a flame electrometer of the Braun type, at distances of 10 and 14 m. from the frame, and along a line at right angles to its centre. At both points the potential passes through three maxima, those at 14 m. distance occurring approximately twice as long after stopping the machine as those at 10 m. away. It is concluded that this is a case of diffusion, but complicated by the formation near the nails, of aggregations, all equally charged, though of different mass.

W. H. Si.

DISCHARGE AND OSCILLATIONS.

1712. *Formation of Positive Ions in Heated Metals.* **Z. Klemensiewicz.** (Acad. Sci. Cracovie, Bull. 6a. pp. 417–424, June, 1911.)—These experiments are carried out in order to settle the question as to the origin of positive ions from heated metals. Three hypotheses have been put forward: The first accounts for the ions by the presence of absorbed gases, the second by traces of impurities, and the third considers them to be the result of chemical reaction [see Abstract No. 118 (1911)]. The apparatus employed is on the same principle as that used by J. J. Thomson, and the metals investigated include Pt, Pd, Au, Ir, Cu, Fe, and W. The temperature of observation is 800° C. Tables of results are given and the conclusion arrived at is that the absorbed gases are responsible for the production of the positive ions. A. E. G.

1713. *Metallic Particles from Heated Metals.* **G. Reboul** and **E. G. de Bollemont.** (Comptes Rendus, 153. pp. 628–630, Oct. 2, 1911.)—Metallic particles are projected from Cu on to Pt when both are heated. The nature of the receiving metal is immaterial except that Ag seems to have its surface worn away rather than added to. The nature of the intervening atmosphere affects the amount of deposit, but the phenomenon is presented in a vacuum. In hydrogen the deposit is formed exteriorly, not opposite to the Cu strip. Silver acts like Cu. Probably the action is due to explosion of occluded gases near the surface; and this would be related to the ready emission of positive charges by Cu and Ag when heated. [See Abstract No. 648 (1911).] A. D.

1714. *Velocity of Ions in Flames.* **A. Bernini.** (N. Cimento, 2. Ser. 6. pp. 101–130, Aug., 1911.)—A critical discussion of the formulæ: (1) J. J. Thomson, mean value of velocity in a space (x_1 to x_2, local forces χ_1 and χ_2) between two plates normal to the field, with flame between, $= K = 8\pi i\,(x_2 - x_1)/(\chi_2^2 - \chi_1^2)$; (2) Child [Abstract No. 847 (1901)], mean value of velocity between flame and plate, $K = 32\pi i x^3/9V^2$ where x is the distance and V the difference of potential between the flame and the plate on which the current i is measured; and (3) Gianfranceschi [Abstract No. 927 (1906)], the value of the velocity per unit gradient the ions have at the distance between flame and plate (independent of the distribution of ions between flame and plate but dependent on the density of ion-layer on the plate), $K = 4\pi i/(\chi\,.\,d\chi/dx)$. An experimental comparison of methods and results follows. The formulæ appear all inadequate and there is no distinct law deducible for the effect of distance or of the strength of field. A. D.

1715. *Infra-red Photoelectric Effect shown by Sensitive Potassium Cells.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 12. pp. 758–761, Sept. 15, 1911.)—If the potassium kathode of a photoelectric cell be covered with a thin layer of the colloidal modification of the metal, the cell becomes very much more sensitive. If a gas such as helium or argon be used in the cell the metal remains in its proper condition. Such a sensitive cell is used by the authors for showing the photoelectric effect brought about by infra-red rays. The effect appears to fall off gradually with increasing wave-length and shows no sudden change. It is pointed out that these sensitive photoelectric cells may be used for investigating the falling-off in the intensity of the light from phosphorescent bodies through a long period of time. In conjunction with a portable galvanometer they form a very convenient means of determining and comparing strong light-intensities. T. P. B.

1716. *Radiation of Mercury Lamp.* **C. Fabry** and **H. Buisson.** (Comptes Rendus, 153. pp. 93–95, July 10, 1911.)—The authors examined three lamps, viz.: one each Heraeus, A.E.G., and Westinghouse, evaluating in absolute units the radiations of the various lines under differing treatment. These measures confirm the facts, previously obtained in the visible region by photometric observation, that the ratios of the intensities of the various radiations vary considerably with the treatment of the lamp. Thus, if we increase the watts consumed, the intensity of the two yellow rays increases much quicker than that of the green ray. E. H. B.

1717. *Ionisation by Incandescent Filament in Vacuum Bulb.* **M. Kinoshita** and **R. Ichinohe.** (Coll. Sci. and Engin., Mem., Kyōtō, 3. pp. 171–188, July, 1911.)—The current-voltage curves due to ionisation by platinum, tungsten, and carbon filaments at various temperatures of the filaments are obtained. The temperatures are determined by an optical method. It is found that with increasing temperature the saturation voltage rises, but not beyond a certain limit. At very high temperatures the saturation current does not agree with that deduced from Richardson's formula [see Abstract No. 1489 (1904)], the former being much greater than the latter. At such high temperatures, even by using as low a voltage as 15 volts, a kind of glow appears in the tube. Thus at temperatures above about 2400° abs., ionisation of the gas molecules by collision with the emitted electrons takes place, even under the influence of a very feeble electric field. At such temperatures the current due to ionisation in the saturation state is roughly half of the actually observed current. T. P. B.

1718. *Condenser Discharge.* **M. Kimura** and **K. Tamaki.** (Coll. Sci. and Engin., Mem., Kyōto, 3. pp. 189–192, July, 1911.)—The nature of the discharge of a condenser circuit through a high resistance is investigated by means of a "glow" oscilloscope tube, which at the same time serves as the high resistance. The discharge takes place by a series of partial discharges, the number of such partial discharges being greater the shorter the spark. Photographs showing the nature of the discharge are given. T. P. B.

1719. *Zehnder Tube as Indicator of Electrical Oscillations.* **W. v. Uljanin.** (Ann. d. Physik, 36. 1. pp. 119–124, Oct. 3, 1911.)—Instead of an accumulator battery, an electrical machine is used with a Zehnder tube [see Abstract No. 1754 (1910)] in the following ways. (1) A vacuum tube of which one electrode is movable is placed in parallel with the Zehnder tube, and the distance between its electrodes is so regulated that the discharge passes only through the vacuum tube. When the resonator is excited the discharge passes through the Zehnder tube. (2) The Zehnder tube is used by itself. If the machine is turned at a particular speed, a certain discharge takes place in the tube, which alters in appearance when the resonator is excited. (3) The electrode of the Zehnder tube near the spark-gap is connected to the negative side of the machine, the other electrode being left unconnected. The glow discharge at the spark-gap is then the indicator of oscillations. A small piece of radio-active substance placed near the spark-gap has the same effect as the electrical machine in this last case. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1720. *Melting-point and Temperature Coefficient of Resistance of Tantalum.* **M. v. Pirani** and **A. R. Meyer.** (Zeitschr. Elektrochem. 17. pp. 908–910, Oct. 15, 1911.)—A method of finding the melting-point of tantalum is now described in which a tantalum wire about 1 mm. diam. is used as anode in a mercury arc lamp. The current is arranged so as to cause the tip of the wire to melt. The results obtained confirm those previously given [see Abstract No. 1168 (1911)]. The temperature-resistance curve for pure Ta from the temperature of liquid air to that of the melting-point of the metal is also investigated. A. E. G.

1721. *Dielectric Constants and Conductivity of Rocks.* **H. Löwy.** (Ann. d. Physik, 36. 1. pp. 125–133, Oct. 3, 1911.)—The paper contains tables giving the results of determinations of the dielectric constants and conductivity of the ordinary constituents of the earth's crust. The dielectric constant is found to lie between 7 and 17. For the majority of specimens the specific resistance is greater than 10^7 ohm × cm. The results depend on the amount of moisture in the stone. The results given are those obtained for specimens which have been at least 10 hours in a dessicator. [See also Abstract No. 1576 (1910).] T. P. B.

1722. *Thermoelectric Power of Graphite.* **E. van Aubel.** (Comptes Rendus, 153. pp. 568–569, Sept. 18, 1911.)—The thermoelectric power of a graphite-copper couple is found to be + 17·8 microvolts per degree between 57·6° and 21·0° C. It rises to +18·4 microvolts per degree for the range 98·5° to 20·9° C. The author has also studied the differences of potential in antimony and in graphite resulting from the action of a magnetic field on a thermal flux normal to the lines of magnetic force. The effect is in the same sense in graphite and in antimony, but is much more intense in graphite. [See also Abstract No. 1234 (1911).] A. D. R.

1723. *Volta-effect in Crystals.* **G. Szivessy.** (Ann. d. Physik, 36. 1. pp 183–186, Oct. 3, 1911.)—In 1890 de Hansen investigated the dependency of the p.d. against an electrolyte of a metallically conducting crystal upon the crystallographic valency of the crystal face in contact with the electrolyte. The author resumes these experiments, but he determines the p.d.'s for various directions through the crystal on the same crystal, not on different specimens. He takes tabular hematite crystals, polishes the bases, grinds two faces at right angles to the bases, and cements small glass tubes to the polished faces. These tubes are filled with zinc sulphate of different concentrations (also ammonium sulphate), and strips of Zn or Pt are immersed in the electrolyte. The p.d.'s observed, about 1·88 volts, did not differ by more than 0·5 per cent. for the two directions at right angles to one another; Hansen's different results, which Hansen had himself questioned, are thus not confirmed. H. B.

1724. *Resistance between Metals and Crystals.* **F. Streintz** and **A. Wellik.** (Phys. Zeitschr. 12. pp. 845–854, Oct. 15, 1911.)—Experiments are described which have for their object the determination of the electrical conductivity of some crystalline bodies, such as galena, pyrites, silver-glance. The difficulty of the experiments lies in obtaining definite electrical contact with the samples under test. The specimens are polished flat, and contact is at first established by placing them between two gold surfaces and pressing the surfaces together with weights. It is found that with this method of contact, the resistance, as measured by a Wheatstone bridge arrangement, falls off with increasing pressure, with increasing current, and with the length of time the pressure has been applied. Even with the heaviest weights Ohm's law is not obeyed. The error is shown to lie in the resistance between the metal surfaces and those of the specimen. It is overcome by amalgamating the gold surfaces. T. P. B.

1725. *Electric Torque of an Electrometer.* **J. Villey.** (Comptes Rendus, 153. pp. 767–769, Oct. 23, 1911.)—The author first finds the torque by Hopkinson's method in terms of the gradients of the capacity coefficients between the quadrants and the moving disc. He points out that this theory is only approximate, for the potential gradients at the surface of the conductors introduce couples comparable to those produced by the electrostatic attraction. In an electrometer having a moving disc of mica silvered over and having bronze quadrants the apparent p.d. of contact between the disc and the bronze quadrants when the deflection was 80° varied between −50 and +60 millivolts. More accurate formulæ are worked out taking these contact p.d.'s into account. A. R

1726. *A Recording Micro-ammeter.* **A. Turpain.** (Le Radium, 8. pp. 388–389, Oct., 1911.)—This instrument is essentially a moving-coil galvanometer having a spring control, the coil being suspended between the pole-pieces of a Weiss electromagnet. With a current in the magnet coils of 8 amps. and a moving coil of 8 ohms' resistance 100 micro-amps. causes a displacement of the pointer equal to 1 mm. Attached to the pointer is a pen which moves over a rotating cylinder, and so records the current. By increasing the resistance of the moving coil to 260 ohms it is possible to increase the sensibility ten-fold. The instrument is suitable for recording the currents taken by a bolometer bridge. W. C. S. P

1727. *A Variable Resistance.* **J. H. Dellinger.** (Phys. Rev. 33. pp. 215–216, Sept., 1911.)—The resistance in its simplest form consists of a tube of thin glass, porcelain or hard rubber containing mercury, electrically connected at the top and bottom. Variation in the resistance is brought about by sliding down the tube an amalgamated copper wire of diam. slightly less than that of the tube. A convenient length is found to be 15 cm., and for a 1-ohm range the tube should have a diam. of about 0·4 mm. In order to make use of these resistances in series it is found best to construct them in the form of U-tubes having the diam. of one leg $\sqrt{10}$ times that of the other. The instrument is unsuitable for exact quantitative work, as it has a large temperature-coefficient. This device has been applied to several measurements, such as determination of low inductances by the alternating-current bridge method. It was found that for moderate frequencies, the variable resistance has a practically non-variable inductance; thus for a certain resistance of 0·05 ohm range the inductance variation was only 6 cm.

W. C. S. P.

ALTERNATING CURRENTS AND MAGNETISM.

1728. *Magnetic Susceptibility of Nickel.* **D. Radovanovitch.** (Archives des Sciences, 32. pp. 315–337, Oct., 1911.)—The paper gives an account of investigations of the initial susceptibility of nickel as a function of the temperature, and the variation of the point of magnetic transformation with the magnetic field. The main results are as follows: (1) Below the transformation-point, the initial susceptibility and the initial slope of the K–H curves increase with the temperature. (2) For a range of temperatures from room temperature to the critical temperature, the initial slope of the K–H curve increases proportionately to the fourth power of the initial susceptibility. (3) The initial susceptibility tends to zero as the temperature tends to absolute zero. (4) The displacement of the temperature of the transformation-point is proportional to the square root of the applied magnetic field. A. D. R.

1729. *Magnetic Properties of Hydrated Salts.* **Mlle. E. Feytis.** (Comptes Rendus, 153. pp. 668–671, Oct. 9, 1911.)—The author has examined whether the magnetic susceptibility of solid salts containing water of crystallisation is an additive function of the susceptibilities of the anhydrous metallic salt and the water present. Taking several such hydrated salts she has determined the susceptibility, K, and hence calculated the theoretical susceptibility, K_0, of the anhydrous salt on the additive law. This value is then compared with K_0, the observed value for the anhydrous substance. Good agreement is obtained in certain cases, such as those of the sulphates of gadolinium and samarium. $NiSO_4$, however, shows a marked discrepancy, which is partly explained by the peculiar behaviour of $CuSO_4$. For $CuSO_4.5H_2O$, she obtains $K = 5{\cdot}9 \times 10^{-6}$, and for $CuSO_4$, $K_c = 9{\cdot}6 \times 10^{-6}$, while $K_0 = 8{\cdot}6 \times 10^{-6}$. Taking, however, the lower hydrate, $CuSO_4.H_2O$, she finds $K_c = K_0 = 8{\cdot}6 \times 10^{-6}$, thereby showing that the last to be expelled of the five molecules of water of crystallisation is more intimately involved in the constitution of the hydrated salt, $CuSO_4.5H_2O$, than the other four. The additive law, then, while generally correct for loosely-combined water molecules, cannot be safely applied to the case of hydrates where the water molecules ought to be regarded as water of constitution. The author questions the accuracy of some determinations of susceptibilities of salts obtained by applying the additive law to observations on aqueous solutions. A. D. R.

RADIOLOGY AND ELECTRO-PHYSIOLOGY.

1730. *The Variations of Intensities and Tension of the Current in Röntgen-ray Tubes.* **A. Wertheimer.** (Archives d'Él. Médicale, 19. pp. 357–372, Oct. 25, 1911. From the German.)—This paper deals chiefly with the curves of the intensities and tensions which have been observed upon a Röntgen-ray tube when excited by a symmetrical alternating current. These curves are arranged in three groups: (*a*) those in which the pressures range from 45 mm. to 0·5 mm., (*b*) those with pressure from 0·5 mm. to 0·01 mm., and (*c*) those of pressures 0·01 to 0·001 mm. In the case of the first group the curves show that the tension at first increases rapidly up to a maximum (explosive potential), then descends more or less rapidly until the point at which the max. intensity is reached. The intensity then diminishes, and the tension rises but always keeps a lower level; more often it remains nearly horizontal, to fall finally very rapidly to zero when the intensity is some milliamps. The curves show a trace of hysteresis quite similar to that of the electric arc as given by Simon. In the curves given for the second group it is seen that when the intensities are very strong, the curves are similar to those of the first group, but the more the pressure is lowered the more modified are the curves. In this case, however, the tension has a smaller value when the intensity increases than when it diminishes. The curves for the third group approach more and more in shape to an obliquely inclined ellipse, the intensity and the tension no longer being zero at one and the same time. Such a characteristic would be obtained if the Röntgen-ray tube behaves like a very high resistance with a capacity in parallel. A. E. G.

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1731. *Magneto-electric Ponderomotor Forces.* **B. Caldonazzo.** (N. Cimento, 2. Ser. 6. pp. 63–79, July, 1911.)—A new deduction, by vector analysis, of the ponderomotor forces exerted by a homogeneous magnetic field upon an infinite continuous rectilinear current. E. E. F.

1732. *Work of the Reichsanstalt in* 1910. (Zeitschr. Instrumentenk. 31. pp. 112–125, April; 148–163, May, and pp. 183–197, June, 1911. Abstract. Engineering, 92. pp. 742–743, Dec. 1, and pp. 775–776, Dec. 8, 1911. Abstract. Electrician, 67. pp. 818–819, Sept. 1, 1911. Abstract.)—A general *résumé* of the work carried out. A. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1733. *The Emission of Electrons as the Result of Chemical Reactions.* **F. Haber** and **G. Just.** (Ann. d. Physik, 36. 2. pp. 308–340, Oct. 13, 1911.)—Experiments have previously been described dealing with the question of the electrons given off by the Na-K alloy, Na, and Li amalgam when their surfaces are being coated with oxide or hydroxide [see Abstract No. 2096 (1909)]. In the present paper experiments are described in which the substances used are in the form of drops, which remain quite clean in the reacting gas. The results obtained show that in a high vacuum the fleeting influence of phosgene gas on a clean Na-K surface in the dark and at ordinary temperature is to set free electrons, as a result of which loss the place of reaction acquires a positive charge of about 1 volt. The electron nature of the negative carriers is certain, on account of their behaviour in magnetic and electric fields. When bromine is substituted for phosgene, electrons are still given off. When the amalgams of Cs, K, and Li are substituted for the Na-K alloy, negative ions are still given off. In all cases the effect is a negative unipolar one, and it takes place in the complete absence of light. A. E. G.

1734. *Limits of Explosibility of Gaseous Mixtures.* **E. P. Perman.** (Nature, 87. p. 416, Sept. 28, 1911.)—Exploding mixtures of gas and air in a glass tube, provided with a stop-cock at each end and a small-bore mercury gauge branching off from the middle, by means of an incandescent Pt-wire, the author observes wider limits of explosibility than are usually assumed. His figures and those of Clowes (in brackets) are: Marsh gas, 2·5 to 24 (5 to 13) per cent.; coal-gas, 4 to 28 (6 to 29) per cent.; hydrogen, 3 to 75 (5 to 72) per cent. The marsh gas was prepared from zinc methyl, as gas from aluminium carbide contained 35 per cent. of hydrogen. Mixtures of coal-dust and air, and of lycopodium powder and air, no other gas being present, were also explosive. H. B.

1735. *Determination of the Coefficient of "Equivalence" of the Special Bronzes. Experiments on Zinc Bronzes.* **L. Guillet** and **L. Revillon.** (Rev. de Métallurgie, 7. pp. 429–436, 1910. Metallurgie, 8. pp. 582–584, Sept. 22, 1911.)—The microscopical examination of bronzes, to which increasing quantities of Zn have been added in place of equal quantities of Sn, shows the appearance of the δ constituent below the limit of solubility for Sn in Cu, and the appearance suggests a higher content of Sn than is actually present. In order to define the effect of Zn on the constitution of the bronzes, its coefficient of "equivalence" has been determined by the methods previously applied by Guillet to the special brasses. The coefficient of equivalence t is expressed by the equation $t = 1 + (A - A')\,100/A'q$, where A is the real Cu-content found by analysis, A′ the apparent Cu-content estimated by observing, under the microscope, the appearance of the δ constituent in samples subjected to long annealing and slow cooling, and q is the zinc-content. Its value varies from $+0{\cdot}035$ to $-0{\cdot}033$, and averages $0{\cdot}030$, but since small errors in the microscopic analysis give rise to considerable variations in the value of t, it can only be assumed that the coefficient of equivalence is in the neighbourhood of zero. This indicates that the effect of Zn on the constitution is very slight. Comparison with results obtained for the special brasses confirms the above conclusions. The solid solution containing Zn is not so hard as one having a similar microscopic appearance, but containing no Zn. F. C. A. H. L.

1736. *Hardness of Quenched Steel with Special Regard to Case-hardened and Quenched Steel.* **A. Portevin** and **H. Berjot.** (Rev. de Métallurgie, 7. pp. 61–75. Metallurgie, 8. pp. 591–594, Sept. 22, 1911)—Experiments have been made on the effect of quenching and tempering on the hardness of a silicon steel (1·46 per cent. Si, 0·56 per cent. C), a medium hard and a hard steel. In order to prevent decarburisation consequent upon oxidation, heating was effected in salt baths, and hardness determined by the Brinell and Shore methods. No positive results can be obtained from a study of the figures, because of surface irregularities in the hardness of steels quenched from high temperatures. Tempering appears to affect the Shore hardness-figure to a lesser degree than the Brinell hardness at temperatures up to 500° C. Experiments on case-hardening mild and nickel steels indicates that while the Shore hardness-figure is a measure of superficial hardness, the Brinell figure is a measure of the depth of the case. Maximum surface hardness in small samples is obtained by quenching Ni steels at 700° C., and ordinary steels at 725° C. after cementing. F. C. A. H. L.

1737. *Growth of Cast Irons after repeated Heatings.* **H. C. H. Carpenter.** (Iron and Steel Inst., Journ. 83. pp. 196–229; Discussion and Correspondence, pp. 230–248, 1911. Mech. Eng. 27. pp. 639–643, May 26, 1911. Abstract.)—In continuation of a previous research [Abstract No. 632 (1910)] the author has shown that P, S, and Mn tend to diminish both the rate of growth and the total growth of cast irons. Dissolved gases, which consist principally of hydrogen and nitrogen, do not affect the growth of "open" irons containing over 3 per cent. Si, but if the Si is below 1 per cent. they may be responsible for a growth of at least 10 per cent. Graphite is essential to growth, but appears to act by providing a channel for the penetration of gases. Silicoferrite is undoubtedly the most potent factor, and the following table has been worked out to show approximately the growth which is likely to take place in any grey iron :—

Si. per cent.	1·00	1·25	1·50	1·75	2·00	2·25	2·50	2·75	3·00	3·25	3·50
Growth, per cent.	15·0	18·5	21·5	24·5	27·0	29·0	31·0	32·5	34·0	35·5	37·0

0·3 per cent. phosphorus will diminish these figures by 2·5 to 4·0 per cent. The growth appears to be caused by the formation of oxide of iron and silica in the heated iron, which materials hinder the contraction of the iron on cooling and contribute to the cracking and deterioration of mechanical properties. Experiments *in vacuo* showed that the samples gave off 0·76 to 1·60 times their volume of gas, and that there is no relation between the behaviour on heating in air and *in vacuo*—in fact, the alloy which shows the most growth in air contracts slightly *in vacuo*, while the alloy which grows least in air expands 11·05 per cent. *in vacuo*. Its growth is due to the internal pressure of dissolved gases which remain permanently imprisoned because of the close nature of the metal. Alloys containing 2·25 to 2·4 per cent. carbon and 0·40 to 0·48 per cent. Si showed a growth after 151 heats, which diminished from 7·49 per cent. to 3·09 per cent. as the Mn increased from 0·51 to 0·935 per cent., and finally an alloy with 2·66 per cent. C, 0·587 per cent. Si, and 1·64 per cent. Mn was obtained, which contracted 0·18 per cent. after 150 heats, after which treatment its strength had been increased from 22·41 to over 24·69 tons per sq. in. It freezes at 1346° C., is very tough, machines like tough malleable iron, and appears to be a suitable material for fire-bars, annealing ovens, &c., where the growth of grey irons is so troublesome. F. C. A. H. L.

1738. *Influence of Impurities on the Corrosion of Iron.* **J. W. Cobb.** (Iron and Steel Inst., Journ. 83. pp. 170–190; Discussion and Correspondence, pp. 191–195, 1911.)—Accepting the electrolytic theory of corrosion and using the ferroxyl indicator, the author has studied the effect of phosphide, sulphide, oxide and silicate of iron, silicate and sulphide of manganese, graphite, &c., and various ferro alloys, on the corrosion of iron. The initiation of corrosion depends upon the contact of the iron with a conducting impurity inside an electrolyte, while the continuation of corrosion necessitates the prevention of polarisation, and that the iron compound formed shall not be impervious and non-conducting. Iron is electro-positive to most of its impurities, the effects of various forms of carbon being particularly marked. Both manganese sulphide and silicate were found to be non-conducting, and consequently not to promote corrosion. Pure Mn and ferro-manganese are electro-positive to iron, resulting in the solution of the Mn. Since the impurities form centres of corrosion it follows that a homogeneous iron is less liable to corrosion than one in which considerable segregation has occurred. F. C. A. H. L.

1739. *Conductivity and Hardness of the Magnesium-Silver System.* **W. J. Smirnow** and **N. S. Kurnakow.** (Ber. d. St. Petersburg Polytechn. Inst. 12. p. 623, 1910. Zeitschr. Anorg. Chem. 72. 1. pp. 31–54, Aug. 24, 1911.)—The differentiation of solid solutions with irrational temperature maxima from definite chemical compounds is quite impossible on simple thermal grounds, since the general appearance of the two equilibrium diagrams is the same. Difficulty arises with the binary compounds which form solid solutions with the excess of both components. There are a number of such compounds whose composition can be represented by the formula $AB_{n}^{n_1 - n_2}$, where n_1 and n_2 represent the concentrations of the solid solutions formed with A and B respectively. To characterise such compounds with a variable composition of the solid phase the study of the electrical conductivity and hardness has been taken up. The authors divide the compounds into two groups—(1) Those passing from the solid to liquid state without decomposition (Ostwald's hylotropic phases), and (2) those which decompose before fusion—and briefly discuss theoretically the nature of the conductivity and hardness diagrams to be expected from such systems in comparison with the corresponding thermal equilibrium diagrams. The electrical conductivity, temperature-coefficient, and Brinell hardness of the Mg-Ag series have been studied at some length. The conductivity and temperature-coefficient diagrams are very similar, and indicate the existence of the two compounds Mg_3Ag and MgAg, the latter corresponding to very pronounced maxima on the curves. The formation of a solid solution of Mg in Ag is indicated by a very considerable fall in the conductivity. Both compounds give rise to solid solutions, the compositions of which can be determined from the curves. Thermal investigation gave no indication of the existence of solid solutions of Mg_3Ag, but the conductivity results have been confirmed by microscopic examination of alloys containing 21 to 26 atoms per cent. of Ag. The temperature coefficient of resistance of the two compounds is a characteristic magnitude, and is almost the same as that of the pure constituents. The hardness diagram confirms the results of the conductivity tests, but a minimum in the electrical properties accompanies a maximum in the hardness, and the maximum on the conductivity curve is accompanied by a minimum hardness. F. C. A. H. L.

1740. *Preparation of Semi-permeable Membranes and Measurement of Molecular Weights by means of Osmotic Pressure.* **E. Fouard.** (Journ. de Physique, 1. Ser. 5. pp. 627–643, Aug., 1911. Paper read before the Soc. franç. de Physique, April 7, 1911.)—It is shown that excellent semi-permeable membranes can be deposited in collodion, *e.g.*, from gelatine and tannic acid or from a copper salt and ferrocyanide. The collodion can be supported by preparing the film on a cylinder of metallic gauze. It is then possible to make direct measurements of osmotic pressure in very dilute solutions. But a more important development consists in the introduction of a differential method by which the osmotic pressure of the solution in the cell is balanced by that of a sugar solution outside. This method is so simple and practical that it may very well become a standard laboratory method of determining molecular weights, competing successfully with the cryoscopic and ebullioscopic methods. The differential method has the advantage that no special attention need be paid to temperature, and that a value can be obtained in an hour instead of a fortnight. The following are typical results for substances of known molecular weight :—

	Concentration.	Sugar Concentration.	Mol. Wt. Found.	Mol. Wt. Calc.
Lactose	3·24	3·085	359·5	360
Glucose monohydrate	2·62	4·51	199	198
Mannite	1·5	2·795	183·2	182·1
Asparagine	1·00	2·518	136	132·2
Quinine tartrate..................	0·25	0·1805	474	474·0
Hydroquinone	1·00	3·02	112·6	110·0

They appear to be more accurate than those obtained with the Beckmann apparatus. T. M. L.

1741. *Changes effected in the Properties of Metals by Working.* **G. Tammann.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 181–196, 1911.)—Experiments made on the lower elastic limits of gold, alloys of Cu-Ag, Cd-Zn, and Cu-Mn in compression, using the microscope to detect the appearance of slip-bands, have given rise to the following conclusions : All metals are increased in strength by working, such as forging, rolling, and drawing. During the increase of strength the crystals are broken down into elementary crystals by planes of slip. Hydrostatic pressure (above elastic limit) does not form slip-bands, and consequently does not increase the strength. The increase in strength is not accompanied by an increase of hardness as determined by the sclerometer. Rapid cooling during crystallisation diminishes the size of the crystals, and consequently increases the strength. Alloys of two metals of practically the same compressive strength show a much greater strength than the constituent metals because of the tendency to form smaller individual crystals. This is specially true of the eutectic. While the elastic properties of the metals are increased, especially by drawing into wire, owing to the formation of slip-bands, and the electrical resistance is increased by the orientation of the lamellæ, other vectorial properties of the metals are relatively unaffected. The scalar properties are, however, affected neither by the breaking-up of the crystals nor their orientation. F. C. A. H. L.

1742. *Densities of Co-existing Phases (Orthobaric Densities) and Diameter of Sulphurous Anhydride in the Neighbourhood of the Critical Point.* **E. Cardoso.** (Comptes Rendus, 153. pp. 257–259, July 24, 1911.)—The author has determined the diameter of sulphurous anhydride in the neighbourhood of the critical point. This diameter is found to be straight until a point about 4° below the critical temperature, when it curves appreciably. At the critical temperature, 157·2°, the density indicated is 0·518, whereas the rectilinear diameter would give 0·520. A. F.

1743. *Viscosity and Fluidity of Emulsions, Crystalline Liquids, a[illegible] Colloidal Solutions.* **E. C. Bingham** and **G. F. White.** (Amer. Chem. Soc., Journ. 33. pp. 1257–1275, Aug., 1911.)—A theoretical discussion is given of the conditions of flow prevailing in an emulsion or colloidal suspension, the theories discussed being those of Hardy, of Ostwald, of Scarpa, of Bose, and of Smoluchowski. On the experimental side it is shown that mixtures of phenol and water increase greatly in viscosity in the neighbourhood of the critical solution temperature, but that this increase begins before the liquid becomes opalescent. It is suggested that conditions in this region are very unstable and that there is a lack of homogeneity before any actual separation of drops takes place. T. M. L.

REFERENCES

1744. *Cementation by Gases.* **A. Portevin.** (Rev. de Métallurgie, 7. pp. 859–885, 1910. Metallurgie, 8. pp. 544–554, Sept. 8, 1911.)—A theoretical discussion of the experiments of previous workers who have shown that cementation is effected by gases containing carbon. F. C. A. H. L.

1745. *Conductivity of Electrolytes from 0° to 35°.* **L. G. Winston** and **H. C. Jones.** (Amer. Chem. Journ. 46. pp. 368–418, Oct., 1911.)—"In the main the results obtained in the case of 30 salts tend to confirm the earlier results." The whole of the work is to be repeated and then summarised at a later date. T. M. L.

1746. *Internal Pressure of a Liquid.* **W. C. McC. Lewis.** (Phil. Mag. 22. pp. 193–197, July, 1911.)—Points out the invalidity of T. W. Richards' formula and advocates the use of that of C. Benedicks as being the most convenient. L. H. W.

1747. *Phenomena of Condensation for Mixtures of Carbonic Acid and Nitrobenzene in connection with Double Retrograde Condensation.* **P. Kohnstamm** and **J. C. Reeders.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 270–278, Oct. 26, 1911. Van der Waals' Funds Researches, No. 3.)

1748. *Thermodynamics of Equilibrium in Single-component Systems.* **G. Tammann.** (Gesell. Wiss. Göttingen, Nachr., Math. Phys. Klasse, 3. pp. 236–260 and 325–360, 1911.) F. J. B.

1749. *Time Curves for Cadmium deposited from Organic Electrolytes.* **M. V. Dover.** (Amer. Chem. Soc., Journ. 33. pp. 1577–1583, Oct., 1911.)